PATENT ABSTRACTS OF JAPAN

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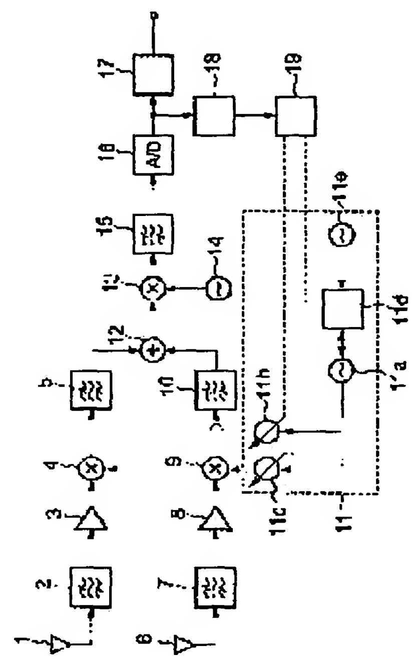
(54) OFDM RECEIVER

(57)Abstract:
PROBLEM TO BE SOLVED: To simplify circuit scale by conducting the diversity combining with an analog circuit and commonly using a part of a high-frequency circuit in all reception systems.
SOLUTION: The receiver comprises a plurality of first mixers 4, 9 for frequency-converting OFDM modulated signals received by a plurality of mutually spaced antennas 1, 6 into first intermediate frequency signals, local oscillation means 11 for feeding first local oscillation signals to the first mixers 4, 9, and adder 12 for combining the first intermediate frequency signals, an A/D converter 16 for converting the combined first intermediate frequency signal into a digital signal, an OFDM-demodulating means 17 for OFDM-demodulating the digital signal, and a phase control means 19 for setting the phase of the first local oscillation signals fed to the first mixers 4, 9, in order that the power of the OFDM-modulating signal already combined is a specified level or higher.



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CLAIMS

[Claim(s)]

[Claim 1] The OFDM receiving set characterized by providing the following. Two or more 1st mixers which carry out frequency conversion of the OFDM modulating signal received with two or more antennas which estranged mutually and have been arranged to the 1st intermediate frequency signal, respectively. A local oscillation means to supply the 1st local oscillation signal to each 1st mixer of the above. The adder which compounds the 1st aforementioned intermediate frequency signal. A phase control means to perform a phase setup of the aforementioned 1st local oscillation signal supplied to each 1st mixer of the above for the power of the A/D converter which changes the 1st intermediate frequency signal of the above after composition into a digital signal, the OFDM recovery means which carries out the OFDM recovery of the aforementioned digital signal, and the OFDM modulating signal after the aforementioned composition becoming more than predetermined level.

[Claim 2] The OFDM receiving set according to claim 1 characterized by carrying out the aforementioned phase setup of the aforementioned 1st local oscillation signal which is equipped with the following, controls each aforementioned phase shifter by the aforementioned phase control means, and is supplied to each 1st mixer of the above. The aforementioned local oscillation means is the 1st one local oscillator which generates the aforementioned 1st local oscillation signal. Two or more phase shifters which are inserted between each 1st mixer of the above, and the 1st local oscillator of the above, control the phase of the aforementioned 1st local oscillation signal, and are supplied to each 1st mixer of the above.

[Claim 3] The OFDM receiving set according to claim 1 characterized by carrying out the aforementioned phase setup of the aforementioned 1st local oscillation signal which is equipped with the following, controls each aforementioned phase shifter by the aforementioned phase control means, and is supplied to each 1st mixer of the above. The aforementioned local oscillation meanses are two or more 1st local oscillators which supply the aforementioned 1st local oscillation signal to each 1st mixer of the above, respectively. Two or more PLL circuits which control each 1st local oscillator of the above, respectively. One source of a reference signal which generates a reference signal. Two or more phase shifters which are inserted between each aforementioned PLL circuit and the aforementioned source of a reference signal, control the phase of the aforementioned reference signal, and are supplied to each aforementioned PLL circuit.

[Claim 4] The OFDM receiving set according to claim 1 characterized by carrying out the aforementioned phase setup of the aforementioned 1st local oscillation signal which is equipped with the following, controls each aforementioned digital synthesizer by the aforementioned phase shift control means, and is supplied to each 1st mixer of the above. The aforementioned local oscillation meanses are two or more 1st local oscillators which supply the aforementioned 1st local oscillation signal to each 1st mixer of the above, respectively. Two or more PLL circuits which control each 1st local oscillator of the above, respectively. Two or more digital synthesizers which control the phase of the aforementioned reference signal and are supplied to each aforementioned PLL circuit while being prepared corresponding to each aforementioned PLL circuit and generating a reference signal.

[Claim 5] The OFDM receiving set according to claim 1 to 6 characterized by preparing the 2nd local oscillator which supplies the 2nd local oscillation signal to the 2nd mixer and the 2nd mixer of the above for carrying out frequency conversion of the 1st intermediate frequency signal by which composition was carried out [aforementioned] to the 2nd intermediate frequency signal between the aforementioned adder and the aforementioned A/D converter.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the OFDM receiving set which has a diversity reception function suitable especially as an object for mount about the OFDM receiving set which receives the OFDM modulating signal used by land-based digital broadcasting.
[0002]
[Description of the Prior Art] In the OFDM receiving set carried in the mobile, since it is easy to be influenced of the level variation of the input signal accompanying phasing, the diversity reception function to avoid ** is added. Drawing 5 shows the composition of the conventional OFDM receiving set which has such a diversity reception function, and consists of two or more receiving systems (you may be two lines for convenience) containing an antenna, a diversity composition means which carries out diversity composition of the signal outputted from each receiving system, and an OFDM recovery means which carries out the OFDM recovery of the signal outputted from a diversity composition means.
[0003] In drawing 5 , one receiving system has an antenna 41, the RF band pass filter 42, the low noise amplifier 43, the 1st mixer 44, the 1st IF band pass filter 45, the 2nd mixer 46, the 2nd IF band pass filter 47, and A/D converter 48. Moreover, the receiving system of another side also has an antenna 51, the RF band pass filter 52, the low noise amplifier 53, the 1st mixer 54, the 1st IF band pass filter 55, the 2nd mixer 56, the 2nd IF band pass filter 57, and A/D converter 58.
[0004] A local oscillation signal is supplied to the 1st two mixer 44 and 54 from the 1st local oscillator 61. Oscillation frequency is controlled by the PLL circuit 62, and, as for the 1st local oscillator 61, a reference signal is supplied to a PLL circuit from criteria VCO 63. Moreover, a local oscillation signal is supplied to the 2nd two mixer 46 and 56 from the 2nd local oscillator 64.

[0005] In the above composition, in one receiving system, frequency conversion of the OFDM modulating signal received with the antenna 41 is carried out to the 1st intermediate frequency signal with the 1st mixer 44, and frequency conversion is further carried out to the 2nd intermediate frequency signal with the 2nd mixer 46. And the 2nd intermediate frequency signal is changed into a digital signal by A/D converter 48.
[0006] Similarly also in the receiving system of another side, frequency conversion of the OFDM modulating signal received with the antenna 51 is carried out to the 1st intermediate frequency signal with the 1st mixer 54, frequency conversion is further carried out to the 2nd intermediate frequency signal with the 2nd mixer 56, and the 2nd intermediate frequency signal is changed into a digital signal by A/D converter 58. And the digital signal outputted from two A/D converters 48 and 58 is inputted into the diversity composition means 65.
[0007] The diversity composition means 65 has 65d of addition meanses to compound two digital signals by which phase correction was carried out to cross-correlation detection means 65a which detects the cross-correlation between the digital signals outputted from two A/D converters 48 and 58, phase shift means 65b which performs phase correction of the digital

signal outputted from one A/D converter, and phase shift means 65c which performs phase correction of the digital signal outputted from A/D converter 58 of another side. And based on the cross-correlation between two digital signals detected by cross-correlation detection means 65a, it is amended so that two digital signals may become in phase.

[0008] A complex-conjugate signal generation means 71 to generate a complex-conjugate signal from one side of the two digital signals with which cross-correlation detection means 65a should compare a phase as shown in drawing 6 , and the multiplication means 72 which carries out multiplication processing of a complex-conjugate signal and the digital signal of another side, It has a accumulation means 73 by which only a predetermined time accumulates a multiplication result, a phase calculation means 74 to calculate the amount of phases which should amend from a accumulation result, and a phase coefficient calculation means 75 to compute two phase coefficients from the calculation result of the amount of phases. And the amount of phases of two phase shift meanses 65a and 65b is amended by the computed phase coefficient.

[0009] Each digital signal in which phase correction was carried out by two phase shift meanses 65b and 65c is compounded by 65d of addition meanses, and the OFDM recovery of the compounded digital signal is carried out by the OFDM recovery means 66. Since it is the same as what is being explained in full detail to the patent application (Japanese Patent Application No. 11-291693) of the point by the applicant of this invention about the composition of the OFDM recovery means 66, and operation, explanation here is omitted.

[0010]

[Problem(s) to be Solved by the Invention] As mentioned above, although two or more OFDM modulating signals which received are changed into a digital signal after frequency conversion, respectively, and phase correction is carried out by digital processing with a diversity composition means after that and being mutually compounded in the conventional OFDM receiving set a circuit scale is huge, even if it constitutes from an IC (integrated circuit), since the complex correlator which consisted of logical circuits, many multipliers, and a divider are included in a cross-correlation detection means or a phase means -- becoming -- moreover, power consumption -- there was a problem of becoming large

[0011] Moreover, since the receiving system from an antenna to an A/D converter had been independent completely for every antenna, there were a scale of the RF circuit which deals with the RF signal of an analog, and a problem of becoming large.

[0012] Then, in this invention, diversity composition is performed by the analog circuit and it aims at sharing a part of RF circuit in all receiving systems, and simplifying a circuit scale further.

[0013]

[Means for Solving the Problem] Two or more 1st mixers which carry out frequency conversion of the OFDM modulating signal received with two or more antennas which estranged mutually and have been arranged by this invention to the above-mentioned technical problem to the 1st intermediate frequency signal, respectively, A local oscillation means to supply the 1st local oscillation signal to each 1st mixer of the above, and the adder which compounds the 1st aforementioned intermediate frequency signal, The A/D converter which changes the 1st intermediate frequency signal of the above after composition into a digital signal, It had a phase control means to perform a phase setup of the aforementioned 1st local oscillation signal supplied to each 1st mixer of the above for the power of the OFDM recovery means which carries out the OFDM recovery of the aforementioned digital signal, and the OFDM modulating signal after the aforementioned composition becoming more than predetermined level.

[0014] Moreover, the 1st one local oscillator in which the aforementioned local oscillation means generates the aforementioned 1st local oscillation signal, It has two or more phase shifters which are inserted between each 1st mixer of the above, and the 1st local oscillator of the above, control the phase of the aforementioned 1st local oscillation signal, and are supplied to each 1st mixer of the above. The aforementioned phase setup of the aforementioned 1st local oscillation signal which controls each aforementioned phase shifter by the aforementioned phase control means, and is supplied to each 1st mixer of the above was carried out.

[0015] Moreover, two or more 1st local oscillators by which the aforementioned local oscillation

means supplies the aforementioned 1st local oscillation signal to each 1st mixer of the above, respectively, Two or more PLL circuits which control each 1st local oscillator of the above, respectively, and one source of a reference signal which generates a reference signal, It has two or more phase shifters which are inserted between each aforementioned PLL circuit and the aforementioned source of a reference signal, control the phase of the aforementioned reference signal, and are supplied to each aforementioned PLL circuit. The aforementioned phase setup of the aforementioned 1st local oscillation signal which controls each aforementioned phase shifter by the aforementioned phase control means, and is supplied to each 1st mixer of the above was carried out.

[0016] Moreover, two or more 1st local oscillators by which the aforementioned local oscillation means supplies the aforementioned 1st local oscillation signal to each 1st mixer of the above, respectively, It is prepared corresponding to two or more PLL circuits which control each 1st local oscillator of the above, respectively, and each aforementioned PLL circuit. While generating a reference signal, it has two or more digital synthesizers which control the phase of the aforementioned reference signal and are supplied to each aforementioned PLL circuit, and the aforementioned phase setup of the aforementioned 1st local oscillation signal which controls each aforementioned digital synthesizer by the aforementioned phase shift control means, and is supplied to each 1st mixer of the above was carried out.

[0017] Moreover, between the aforementioned adder and the aforementioned A/D converter, the 2nd local oscillator which supplies the 2nd local oscillation signal to the 2nd mixer and the 2nd mixer of the above for carrying out frequency conversion of the 1st intermediate frequency signal by which composition was carried out [aforementioned] to the 2nd intermediate frequency signal was prepared.

[0018]

[Embodiments of the Invention] Hereafter, although the OFDM receiving set of this invention is explained according to a drawing, two or more receiving systems are explained as 2. Drawing 1 shows the 1st operation form, one receiving system has an antenna 1, the RF band pass filter 2, the low noise amplifier 3, the 1st mixer 4, and the 1st IF (intermediate frequency) band pass filter 5, and the receiving system of another side also has an antenna 6, the RF band pass filter 7, the low noise amplifier 8, the 1st mixer 9, and the 1st IF band pass filter 10. The 1st local oscillation signal is inputted into the 1st two mixer 3 and 8 from the local oscillation means 11.

[0019] 1st local-oscillator 11a in which the local oscillation means 11 generates the 1st local oscillation signal, Two phase shifters 11b and 11c which control the phase of the 1st local oscillation signal and are individually supplied to the 1st two mixer 4 and 9, respectively, It has 11d of PLL circuits which control 1st local-oscillator 11a and set up the frequency of the 1st local oscillation signal, and source of reference signal 11e which generates a reference signal and is supplied to 11d of PLL circuits.

[0020] And it is received by each antennas 1 and 6, each RF filters 2 and 7 are passed, and the OFDM modulating signal amplified with each low noise amplifier 3 and 5 is inputted into each 1st mixer 4 and 9. It is mixed with the 1st local oscillation signal, and frequency conversion of the OFDM modulating signal inputted into each 1st mixer 4 and 9 is carried out to the 1st intermediate frequency signal, the 1st intermediate frequency signal outputted from one 1st mixer 4 and the 1st intermediate frequency signal outputted from the 1st mixer 9 of another side are inputted into an adder 12 through each 1st IF band pass filters 5 and 10, respectively, and diversity composition of it is carried out here.

[0021] It is inputted into the 2nd mixer 13, it is mixed with the 2nd local oscillation signal supplied from the 2nd local oscillator 14, and frequency conversion of the 1st compounded intermediate frequency signal is carried out to the 2nd intermediate frequency signal. The 2nd intermediate frequency signal passes the 2nd IF band pass filter 15, is inputted into A/D converter 16, and is changed into a digital signal here. And it restores to a digital signal by the OFDM recovery means 17. The OFDM recovery means 17 is the same composition as conventional it.

[0022] Moreover, a digital signal is inputted into the power detection means 18. The power detection means 18 detects the power which is proportional to the size of the 2nd intermediate

frequency signal with the inputted digital signal, and the detected power is inputted into the phase control means 19. The phase control means 19 controls the phase of the 1st local oscillation signal by two phase shifters 11b and 11c in the local oscillation means 11. As a result of the phase control, it is controlled so that the power detected becomes more than predetermined level. In this phase control, it is considered that it is not influenced of the level variation of the input signal accompanying phasing. Next, the phase control is explained with reference to the flow chart of drawing 2 .

[0023] The phase control means 19 has the microcomputer and memory (not shown) for performing a series of control action inside. First, the step 1 (referred to as STP1 in drawing 2 .) the following -- being the same -- the phase contrast between two OFDM modulating signals (the 2nd intermediate frequency signal) outputted from two mixers 4 and 9 changes from 0 degree to 360 degrees -- as -- each phase-shifter 11b -- The phase contrast (phi) between the 1st local oscillation signals which control 11c and are inputted into each 1st mixer 4 and 9 is changed, and it asks for the phase contrast (phi 0) and the maximum power between the 1st local oscillation signals in case the power (P) of the 2nd intermediate frequency signal after composition serves as the maximum (P0).

[0024] Next, it is compared by Step 2 whether the power P which set up each phase shifters 11b and 11c so that phase contrast phi might be set to phi 0, measured the power P at that time at Step 3, and was measured at Step 4 is more than predetermined level. Predetermined level here is level which is carrying out the fixed power (dP) fall rather than the maximum power P0, and it is shown by (P0-dP). And if it is P< (P0-dP), it will return to the process of Step 3, if it is P> (P0-dP), it will progress to Step 5, and it updates to phi+d phi which did the increase of phase contrast phi in fixed phase contrast dphi. And power P+ at that time is measured (Step 6).

[0025] It is compared by Step 7 whether the measured power (P+) is declining more than predetermined level again. And if it is P+< (P0-dP), it will return to the process of Step 3, and if it is P+> (P0-dP), it will progress to Step 8 and phase contrast phi will be updated to (phi-2dphi). And power P- at that time is measured (Step 9).

[0026] It is compared by Step 10 whether measured power P- is falling more than predetermined level again. And if it is P-> (P0-dP), it will return to Step 3, and if it is P-< (P0-dP), it will return to Step 1.

[0027] The power of the 2nd intermediate frequency signal is controlled to always become more than the predetermined level that fell fixed power dP from a maximum power P0, the 1st intermediate frequency signal outputted from the 1st two mixer 4 and 9 becomes almost in phase, and diversity composition of it is carried out with an adder 12 by the above flow.

[0028] That what is necessary is just to control the phase of the 1st local oscillation signal by the 1st operation form explained above although diversity composition is carried out, since the 2nd mixer or subsequent ones can be communalized, composition can simplify by leaps and bounds.

[0029] Drawing 3 shows the 2nd operation form. In drawing 3 , it is the composition of a local oscillation means, and a different place from drawing 1 attaches the same sign about other composition, and omits explanation.

[0030] A local oscillation means 21 to supply the 1st local oscillation signal to the 1st two mixer 4 and 5 1st local-oscillator 21a which supplies the 1st local oscillation signal to one 1st mixer 4, 2nd local-oscillator 21b which supplies the 1st local oscillation signal to the 1st mixer 9 of another side, PLL circuit 21c which sets up the oscillation frequency of one 1st local-oscillator 21a, It has 21d of PLL circuits which set up the oscillation frequency of 1st local-oscillator 21b of another side, source of reference signal 21e which generates a reference signal, and the phase shifters 21f and 21g which control the phase of a reference signal and are supplied to the PLL circuits 21c and 21d, respectively.

[0031] and the oscillation frequency of the 1st two local oscillator 21a and 21b set up by two PLL circuits 21c and 21d is mutually the same -- a value -- **

[0032] Although the phase control means 19 performs a phase setup of two phase shifters 21f and 21g directly, the phase relation of the 1st local oscillation signal supplied to the 1st two mixer 4 and 9 is decided by this. Therefore, a phase setup of the 1st local oscillation signal

supplied to each 1st mixer 4 and 9 from the 1st local oscillator 21a and 21b is carried out indirectly. The phase relation of the 1st intermediate frequency signal outputted from the 1st two more mixer 4 and 9 is also decided. And although phase shifters 21f and 21g are controlled instead of the phase shifters 11b and 11c of drawing 1 , since the control method is the same as the content explained by drawing 2 , explanation is omitted.
[0033] since 1 changes 2g of phases of the reference signal which is single frequency 21f of phase shifters in the 2nd operation gestalt, the property of a wide band is unnecessary, the frequency of a reference signal is boiled markedly, it is a low and the loss of the 1st local oscillation signal by insertion of phase shifters 21f and 21g of it is also lost from the frequency of the 1st local oscillation signal
[0034] Although prepared source of standard signal 21e in the local oscillation means 21 in the 2nd operation gestalt, the reference signal was generated, the phase of a reference signal was controlled by phase shifters 21f and 21g and each PLL circuits 21c and 21d were supplied, as shown in drawing 4 , while generating a reference signal by the digital synthesizer, the phase may be controlled and the PLL circuits 21c and 21d may be supplied.
[0035] Drawing 4 shows the composition of the local oscillation means 31 at the time of using a digital synthesizer, and the digital synthesizers 31a and 31b have ROM, respectively. An amplitude and a phase are dispersed to each ROM and the data of the sine wave for one period are stored in it. And a clock and frequency data are inputted into each digital synthesizers 31a and 31b in common, and each ROM generates the data of a sine wave with which frequency becomes the same synchronizing with a clock.
[0036] Moreover, phase data are individually inputted into each digital synthesizers 31a and 31b. It is digital-signal-ized although this phase data is inputted from the phase control means 19. The phase of the data of a sine wave is determined by this. The data of the sine wave outputted from each ROM are changed into an analog sine wave by D/A converters 31c and 31d, respectively. The signal of this analog sine wave is inputted into the PLL circuits 21c and 21d through the bandpass path filters 31e and 31f, respectively as a reference signal. Since the frequency and the phase of a reference signal can be set up in digital ones if a digital synthesizer is used as mentioned above, it is easy.
[0037]
[Effect of the Invention] Since it had a phase control means to perform a phase setup of the 1st local oscillation signal supplied to each 1st mixer for carrying out frequency conversion of the OFDM modulating signal received with two or more antennas which estranged mutually and have been arranged in this invention to the 1st intermediate frequency signal, respectively, compounding it, and the power of the OFDM modulating signal after composition becoming more than predetermined level as explained above, diversity composition can be performed in an analog circuit. Therefore, composition becomes easy.
[0038] Moreover, the 1st one local oscillator in which a local oscillation means generates the 1st local oscillation signal, It has two or more phase shifters which are inserted between each 1st mixer and the 1st local oscillator, control the phase of the 1st local oscillation signal, and are supplied to each 1st mixer. Since a phase setup of the 1st local oscillation signal which controls each phase shifter by the phase control means, and is supplied to each 1st mixer was carried out, the composition of a local oscillation means can also be simplified.
[0039] Moreover, two or more 1st local oscillators by which a local oscillation means supplies the 1st local oscillation signal to each 1st mixer, respectively, Two or more PLL circuits which control each 1st local oscillator, respectively, and one source of a reference signal which generates a reference signal, It has two or more phase shifters which are inserted between each PLL circuit and the source of a reference signal, control the phase of a reference signal, and are supplied to each PLL circuit. Since a phase setup of the 1st local oscillation signal which controls each phase shifter by the phase control means, and is supplied to each 1st mixer was carried out since the property of a wide band is unnecessary since a phase shifter changes the phase of the reference signal which is single frequency, and the frequency of a reference signal is alike and lower than the frequency of the 1st local oscillation signal, loss of the 1st local oscillation signal by insertion of a phase shifter is also lost

[0040] Moreover, since a phase setup of the 1st local oscillation signal which has two or more digital synthesizers which control the phase of a reference signal and are supplied to each PLL circuit, controls each digital synthesizer by phase shift control means, and is supplied to each 1st mixer was carried out while the local oscillation means was established corresponding to two or more PLL circuits which control each 1st local oscillator, respectively, and each PLL circuit and generating the reference signal, a digital phase setup is attained.
[0041] Moreover, since the 2nd local oscillator which supplies the 2nd local oscillation signal to the 2nd mixer and the 2nd mixer for carrying out frequency conversion of the 1st compounded intermediate frequency signal to the 2nd intermediate frequency signal was prepared between the adder and the A/D converter and the 2nd mixer or subsequent ones consists of one line, the composition of the OFDM receiving set of a double conversion method becomes easy.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the circuit diagram showing the composition of the 1st operation gestalt of the OFDM receiving set of this invention.
[Drawing 2] It is a flow chart explaining operation of the OFDM receiving set of this invention.
[Drawing 3] It is the circuit diagram showing the composition of the 2nd operation gestalt of the OFDM receiving set of this invention.
[Drawing 4] It is the circuit diagram showing other composition of the local oscillation means in the 2nd operation gestalt of the OFDM receiving set of this invention.
[Drawing 5] It is the circuit diagram showing the composition of the conventional OFDM receiving set.
[Drawing 6] It is the circuit diagram showing the composition of the cross-correlation detection means in the conventional OFDM receiving set.
[Description of Notations]
1 Six Antenna
2 Seven RF band pass filter
3 Eight Low noise amplifier
4 Nine The 1st mixer
5 Ten The 1st IF band pass filter
11 Local Oscillation Means
11a The 1st local oscillator
11b, 11c Phase shifter
11d PLL circuit
11e The source of a standard signal
12 Adder
13 2nd Mixer
14 2nd Local Oscillator
15 2nd IF Band Pass Filter
16 A/D Converter
17 OFDM Recovery Means
18 Power Detection Means
19 Phase Control Means
21 Local Oscillation Means
21a, 21b The 1st local oscillator
21c, 21d PLL circuit
21e The source of a standard signal
21f, 21g Phase shifter
31 Local Oscillation Means
31a, 31b Digital synthesizer
31c, 31d D/A converter
31e, 31f Band pass filter

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13 2nd Mixer
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17 OFDM Recovery Means
18 Power Detection Means
19 Phase Control Means
21 Local Oscillation Means
21a, 21b The 1st local oscillator
21c, 21d PLL circuit
21e The source of a standard signal
21f, 21g Phase shifter
31 Local Oscillation Means
31a, 31b Digital synthesizer
31c, 31d D/A converter
31e, 31f Band pass filter

[Translation done.]

* NOTICES *

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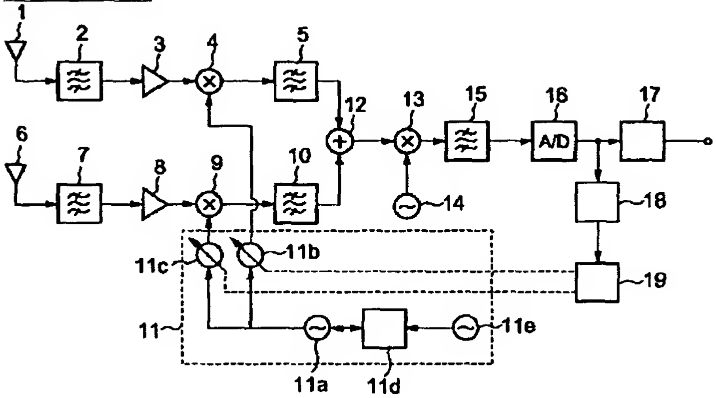
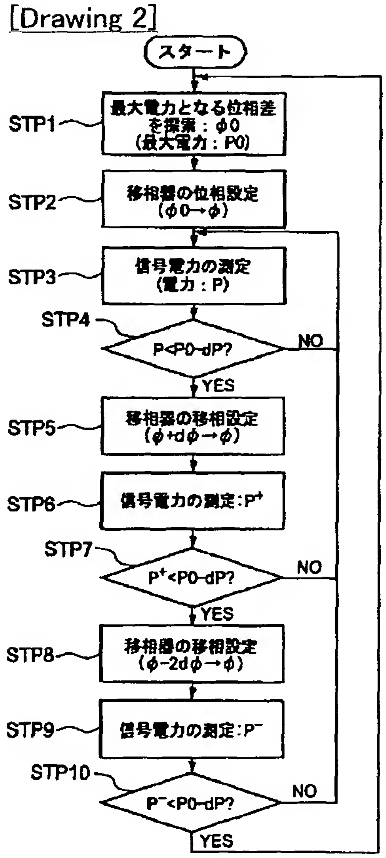
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

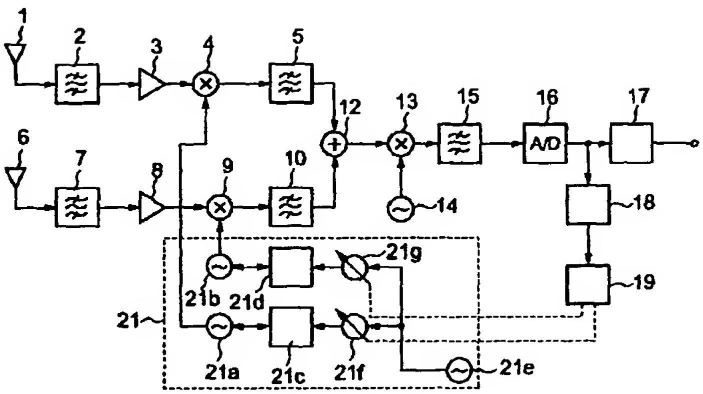
[Drawing 1]



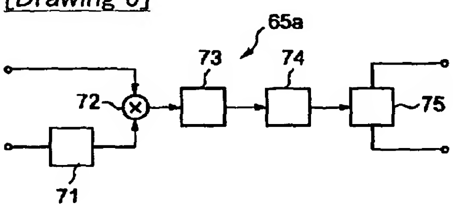
[Drawing 2]



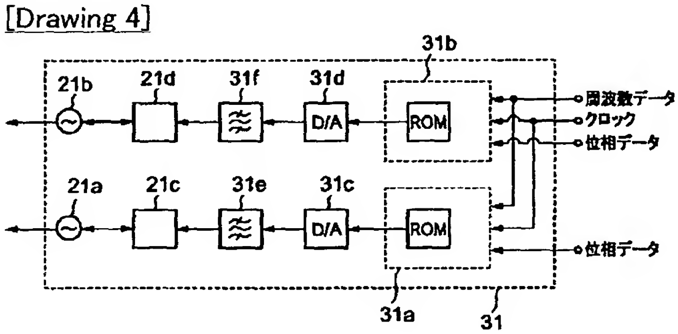
[Drawing 3]



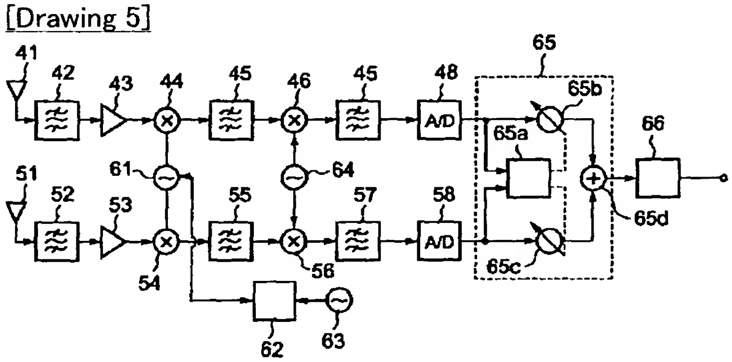
[Drawing 6]



[Drawing 4]



[Drawing 5]



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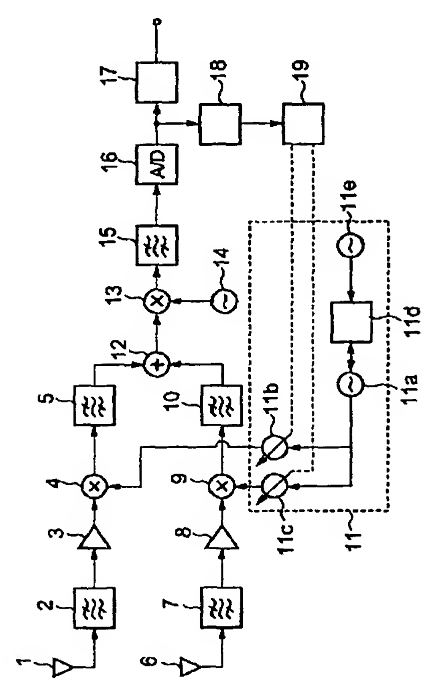
(54)【発明の名称】　ＯＦＤＭ受信装置

(57)【要約】

【課題】　アナログ回路でダイバーシチ合成を行い、さらに、高周波回路の一部を全ての受信系統で共用して回路規模を簡素化する。

【解決手段】　互いに離間して配置された複数のアンテナ１、６で受信されたＯＦＤＭ変調信号をそれぞれ第１中間周波信号に周波数変換する複数の第１混合器４、９と、各第１混合器４、９に第１局部発振信号を供給する局部発振手段１１と、第１中間周波信号同士を合成する加算器１２と、合成後の第１中間周波信号をデジタル信号に変換するＡ／Ｄ変換器１６と、デジタル信号をＯＦＤＭ復調するＯＦＤＭ復調手段１７と、合成後のＯＦＤＭ変調信号の電力が所定レベル以上となるための各第１混合器４、９に供給される第１局部発振信号の位相設定を行う位相制御手段１９とを備えた。



【特許請求の範囲】

【請求項１】　互いに離間して配置された複数のアンテナで受信されたＯＦＤＭ変調信号をそれぞれ第１中間周波信号に周波数変換する複数の第１混合器と、前記各第１混合器に第１局部発振信号を供給する局部発振手段と、前記第１中間周波信号同士を合成する加算器と、合成後の前記第１中間周波信号をデジタル信号に変換するＡ／Ｄ変換器と、前記デジタル信号をＯＦＤＭ復調するＯＦＤＭ復調手段と、前記合成後のＯＦＤＭ変調信号の電力が所定レベル以上となるための前記各第１混合器に供給される前記第１局部発振信号の位相設定を行う位相制御手段とを備えたことを特徴とするＯＦＤＭ受信装置。

【請求項２】　前記局部発振手段は前記第１局部発振信号を発生する一つの第１局部発振器と、前記各第１混合器と前記第１局部発振器との間に介挿され、前記第１局部発振信号の位相を制御して前記各第１混合器に供給する複数の移相器とを有し、前記位相制御手段によって前記各移相器を制御して前記各第１混合器に供給される前記第１局部発振信号の前記位相設定をしたことを特徴とする請求項１に記載のＯＦＤＭ受信装置。

【請求項３】　前記局部発振手段は前記各第１混合器にそれぞれ前記第１局部発振信号を供給する複数の第１局部発振器と、前記各第１局部発振器をそれぞれ制御する複数のＰＬＬ回路と、基準信号を発生する一つの基準信号源と、前記各ＰＬＬ回路と前記基準信号源との間に介挿され、前記基準信号の位相を制御して前記各ＰＬＬ回路に供給する複数の移相器とを有し、前記位相制御手段によって前記各移相器を制御して前記各第１混合器に供給される前記第１局部発振信号の前記位相設定をしたことを特徴とする請求項１に記載のＯＦＤＭ受信装置。

【請求項４】　前記局部発振手段は前記各第１混合器にそれぞれ前記第１局部発振信号を供給する複数の第１局部発振器と、前記各第１局部発振器をそれぞれ制御する複数のＰＬＬ回路と、前記各ＰＬＬ回路に対応して設けられ、基準信号を発生すると共に前記基準信号の位相を制御して前記各ＰＬＬ回路に供給する複数のデジタルシンセサイザとを有し、前記移相制御手段によって前記各デジタルシンセを制御して前記各第１混合器に供給される前記第１局部発振信号の前記位相設定をしたことを特徴とする請求項１に記載のＯＦＤＭ受信装置。

【請求項５】　前記加算器と前記Ａ／Ｄ変換器との間には、前記合成された第１中間周波信号を第２中間周波信号に周波数変換するための第２混合器と前記第２混合器に第２局部発振信号を供給する第２局部発振器とを設けたことを特徴とする請求項１乃至６のいずれかに記載のＯＦＤＭ受信装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、地上波デジタル放送で使用されるＯＦＤＭ変調信号を受信するＯＦＤＭ受信装置に関し、特に車載用として好適なダイバーシチ受信機能を有するＯＦＤＭ受信装置に関する。

【０００２】

【従来の技術】移動体に搭載されたＯＦＤＭ受信装置では、フェージングに伴う受信信号のレベル変動の影響を受けやすいため、此を回避するダイバーシチ受信機能が付加される。図５はこのようなダイバーシチ受信機能を有する従来のＯＦＤＭ受信装置の構成を示し、アンテナを含む複数の受信系統（便宜上２系統とする）と、各受信系統から出力される信号をダイバーシチ合成するダイバーシチ合成手段と、ダイバーシチ合成手段から出力される信号をＯＦＤＭ復調するＯＦＤＭ復調手段とから構成される。

【０００３】図５において、一方の受信系統はアンテナ４１、ＲＦバンドパスフィルタ４２、ローノイズアンプ４３、第１混合器４４、第１ＩＦバンドパスフィルタ４５、第２混合器４６、第２ＩＦバンドパスフィルタ４７、Ａ／Ｄ変換器４８を有する。　また、他方の受信系統もアンテナ５１、ＲＦバンドパスフィルタ５２、ローノイズアンプ５３、第１混合器５４、第１ＩＦバンドパスフィルタ５５、第２混合器５６、第２ＩＦバンドパスフィルタ５７、Ａ／Ｄ変換器５８を有する。

【０００４】二つの第１混合器４４、５４には第１局部発振器６１から局部発振信号が供給される。第１局部発振器６１はＰＬＬ回路６２によって発振周波数が制御され、ＰＬＬ回路には基準発振器６３から基準信号が供給される。また、二つの第２混合器４６、５６には第２局部発振器６４から局部発振信号が供給される。

【０００５】以上の構成において、一方の受信系統ではアンテナ４１で受信されたＯＦＤＭ変調信号が第１混合器４４で第１の中間周波信号に周波数変換され、更に第２混合器４６で第２の中間周波信号に周波数変換される。そして、第２中間周波信号はＡ／Ｄ変換器４８によってデジタル信号に変換される。

【０００６】同様に、他方の受信系統においても、アンテナ５１で受信されたＯＦＤＭ変調信号が第１混合器５４で第１の中間周波信号に周波数変換され、更に第２混合器５６で第２の中間周波信号に周波数変換され、第２中間周波信号はＡ／Ｄ変換器５８によってデジタル信号に変換される。そして、二つのＡ／Ｄ変換器４８、５８から出力されたデジタル信号はダイバーシチ合成手段６５に入力される。

【０００７】ダイバーシチ合成手段６５は、二つのＡ／Ｄ変換器４８、５８から出力されたデジタル信号間の相互相関を検出する相互相関検出手段６５ａと、一方のＡ／Ｄ変換器から出力されたデジタル信号の位相補正を行う移相手段６５ｂ、他方のＡ／Ｄ変換器５８から出力されたデジタル信号の位相補正を行う移相手段６５ｃと、位相補正された二つのデジタル信号を合成する加算手段

６５ｄとを有する。そして、相互相関検出手段６５ａによって検出された二つのデジタル信号間の相互相関に基づいて、二つのデジタル信号が同位相となるように補正される。

【０００８】相互相関検出手段６５ａは図６に示すように、位相を比較すべき二つのデジタル信号のうちの一方から複素共役信号を生成する複素共役信号生成手段７１、複素共役信号と他方のデジタル信号とを乗算処理する乗算手段７２と、乗算結果を所定時間だけ累算する累算手段７３と、累算結果から補正すべき位相量を計算する位相算出手段７４と、位相量の計算結果から二つの位相係数を算出する位相係数算出手段７５とを有する。そして、算出された位相係数によって二つの移相手段６５ａ、６５ｂの位相量が補正される。

【０００９】二つの移相手段６５ｂ、６５ｃによって位相補正されたそれぞれのデジタル信号は加算手段６５ｄによって合成され、合成されたデジタル信号はＯＦＤＭ復調手段６６によってＯＦＤＭ復調される。ＯＦＤＭ復調手段６６の構成と動作については本発明の出願人による先の特許出願（特願平１１－２９１６９３）に詳述しているものと同じであるので、ここでの説明は省略する。

【００１０】

【発明が解決しようとする課題】以上のように、従来のＯＦＤＭ受信装置では、受信した複数のＯＦＤＭ変調信号をそれぞれ周波数変換後にデジタル信号に変換し、その後にダイバーシチ合成手段でデジタル処理によって位相補正して互いに合成しているが、相互相関検出手段や位相手段には論理回路で構成された複素相関器や多数の乗算器、除算器を含むため、ＩＣ（集積回路）で構成しても回路規模が膨大となり、また消費電力大きくなるという問題があった。

【００１１】また、アンテナからＡ／Ｄ変換器までの受信系統がアンテナ毎に完全に独立しているので、アナログの高周波信号を取り扱う高周波回路の規模も大きくなるという問題もあった。

【００１２】そこで、本発明においては、アナログ回路でダイバーシチ合成を行い、さらに、高周波回路の一部を全ての受信系統で共用して回路規模を簡素化することを目的とする。

【００１３】

【課題を解決するための手段】上記課題に対して、本発明では、互いに離間して配置された複数のアンテナで受信されたＯＦＤＭ変調信号をそれぞれ第１中間周波信号に周波数変換する複数の第１混合器と、前記各第１混合器に第１局部発振信号を供給する局部発振手段と、前記第１中間周波信号同士を合成する加算器と、合成後の前記第１中間周波信号をデジタル信号に変換するＡ／Ｄ変換器と、前記デジタル信号をＯＦＤＭ復調するＯＦＤＭ復調手段と、前記合成後のＯＦＤＭ変調信号の電力が所定レベル以上となるための前記各第１混合器に供給される前記第１局部発振信号の位相設定を行う位相制御手段とを備えた。

【００１４】また、前記局部発振手段は前記第１局部発振信号を発生する一つの第１局部発振器と、前記各第１混合器と前記第１局部発振器との間に介挿され、前記第１局部発振信号の位相を制御して前記各第１混合器に供給する複数の移相器とを有し、前記位相制御手段によって前記各移相器を制御して前記各第１混合器に供給される前記第１局部発振信号の前記位相設定をした。

【００１５】また、前記局部発振手段は前記各第１混合器にそれぞれ前記第１局部発振信号を供給する複数の第１局部発振器と、前記各第１局部発振器をそれぞれ制御する複数のＰＬＬ回路と、基準信号を発生する一つの基準信号源と、前記各ＰＬＬ回路と前記基準信号源との間に介挿され、前記基準信号の位相を制御して前記各ＰＬＬ回路に供給する複数の移相器とを有し、前記位相制御手段によって前記各移相器を制御して前記各第１混合器に供給される前記第１局部発振信号の前記位相設定をした。

【００１６】また、前記局部発振手段は前記各第１混合器にそれぞれ前記第１局部発振信号を供給する複数の第１局部発振器と、前記各第１局部発振器をそれぞれ制御する複数のＰＬＬ回路と、前記各ＰＬＬ回路に対応して設けられ、基準信号を発生すると共に前記基準信号の位相を制御して前記各ＰＬＬ回路に供給する複数のデジタルシンセサイザとを有し、前記移相制御手段によって前記各デジタルシンセを制御して前記各第１混合器に供給される前記第１局部発振信号の前記位相設定をした。

【００１７】また、前記加算器と前記Ａ／Ｄ変換器との間には、前記合成された第１中間周波信号を第２中間周波信号に周波数変換するための第２混合器と前記第２混合器に第２局部発振信号を供給する第２局部発振器とを設けた。

【００１８】

【発明の実施の形態】以下、本発明のＯＦＤＭ受信装置を図面に従って説明するが、複数の受信系統を２として説明する。図１は第１の実施形態を示し、一方の受信系はアンテナ１、ＲＦバンドパスフィルタ２、ローノイズアンプ３、第１混合器４、第１ＩＦ（中間周波）バンドパスフィルタ５を有し、他方の受信系統もアンテナ６、ＲＦバンドパスフィルタ７、ローノイズアンプ８、第１混合器９、第１ＩＦバンドパスフィルタ１０を有する。二つの第１混合器３、８には局部発振手段１１から第１局部発振信号が入力される。

【００１９】局部発振手段１１は第１局部発振信号を発生する第１局部発振器１１ａと、第１局部発振信号の位相を制御してそれぞれ個別に二つの第１混合器４、９に供給する二つの移相器１１ｂ、１１ｃと、第１局部発振器１１ａを制御して第１局部発振信号の周波数を設定す

るＰＬＬ回路１１ｄと、基準信号を発生してＰＬＬ回路１１ｄに供給する基準信号源１１ｅとを有する。

【００２０】そして、各アンテナ１、６で受信され、各ＲＦフィルタ２、７を通過し、各ローノイズアンプ３、５によって増幅されたＯＦＤＭ変調信号が各第１混合器４、９に入力される。各第１混合器４、９に入力されたＯＦＤＭ変調信号は第１局部発振信号と混合されて、第１中間周波信号に周波数変換され、一方の第１混合器４から出力された第１中間周波信号と、他方の第１混合器９から出力された第１中間周波信号とがそれぞれ各第１ＩＦバンドパスフィルタ５、１０を介して加算器１２に入力され、ここでダイバーシチ合成される。

【００２１】合成された第１中間周波信号は第２混合器１３に入力され、第２局部発振器１４から供給される第２局部発振信号と混合されて第２中間周波信号に周波数変換される。第２中間周波信号は第２ＩＦバンドパスフィルタ１５を通過してＡ／Ｄ変換器１６に入力され、ここでデジタル信号に変換される。そして、デジタル信号はＯＦＤＭ復調手段１７によって復調される。ＯＦＤＭ復調手段１７は従来のそれと同じ構成である。

【００２２】また、デジタル信号は電力検出手段１８に入力される。電力検出手段１８は入力されたデジタル信号によって第２中間周波信号の大きさに比例する電力を検出し、検出された電力は位相制御手段１９に入力される。位相制御手段１９は局部発振手段１１における二つの移相器１１ｂ、１１ｃによる第１局部発振信号の位相を制御するものである。その位相制御の結果、検出される電力が所定レベル以上となるように制御される。この位相制御においては、フェージングに伴う受信信号のレベル変動の影響を受けないように考慮されている。次に、その位相制御について図２のフローチャートを参照して説明する。

【００２３】位相制御手段１９は一連の制御動作を行うためのマイクロコンピュータやメモリ（図示せず）を内部に有している。先ず、ステップ１（図２ではＳＴＰ１とする。以下同様）で二つの混合器４、９から出力される２系統のＯＦＤＭ変調信号（第２中間周波信号）間の位相差が０°から３６０°まで変化するように各移相器１１ｂ、１１ｃを制御して各第１混合器４、９に入力される第１局部発振信号間の位相差（Φ）を変化させ、合成後の第２中間周波信号の電力（Ｐ）が最大となるときの第１局部発振信号間の位相差（Φ０）とその最大電力を（Ｐ０）求める。

【００２４】次に、ステップ２では位相差ΦがΦ０となるように各移相器１１ｂ、１１ｃを設定し、ステップ３ではそのときの電力Ｐを測定し、ステップ４では測定された電力Ｐが所定レベル以上であるか否かが比較される。ここでの所定レベルとは、最大電力Ｐ０よりも一定電力（ｄＰ）低下しているレベルであり、（Ｐ０−ｄＰ）で示される。そして、Ｐ＜（Ｐ０−ｄＰ）であればステップ３の工程に戻り、Ｐ＞（Ｐ０−ｄＰ）であればステップ５に進んで、位相差Φを一定位相差ｄΦ増加したΦ＋ｄΦに更新する。そして、そのときの電力P^{+}を測定する（ステップ６）。

【００２５】ステップ７では、測定された電力（P^{+}）が再び所定レベル以上低下しているか否かが比較される。そして、P^{+}＜（Ｐ０−ｄＰ）であればステップ３の工程に戻り、P^{+}＞（Ｐ０−ｄＰ）であればステップ８に進んで、位相差Φを（Φ−２ｄΦ）に更新する。そしてそのときの電力P^{-}を測定する（ステップ９）。

【００２６】ステップ１０では、測定された電力P^{-}が再び所定レベル以上低下しているか否かが比較される。そして、P^{-}＞（Ｐ０−ｄＰ）であればステップ３に戻り、P^{-}＜（Ｐ０−ｄＰ）であればステップ１に戻る。

【００２７】以上の流れによって、第２中間周波信号の電力は常に最大電力Ｐ０よりも一定電力ｄＰ下がった所定レベル以上となるように制御され、二つの第１混合器４、９から出力された第１中間周波信号同士がほぼ同相となって加算器１２によってダイバーシチ合成される。

【００２８】以上説明した第１の実施形態では、ダイバーシチ合成するのに第１局部発振信号の位相を制御するだけでよく、また、第２混合器以降を共通化できるので構成が飛躍的に簡素化出来る。

【００２９】図３は第２の実施形態を示す。図３において、図１と異なるところは局部発振手段の構成であり、その他の構成については同一符号を付して説明を省略する。

【００３０】二つの第１混合器４、５に第１局部発振信号を供給する局部発振手段２１は、一方の第１混合器４に第１局部発振信号を供給する第１局部発振器２１ａと、他方の第１混合器９に第１局部発振信号を供給する第２局部発振器２１ｂと、一方の第１局部発振器２１ａの発振周波数を設定するＰＬＬ回路２１ｃと、他方の第１局部発振器２１ｂの発振周波数を設定するＰＬＬ回路２１ｄと、基準信号を発生する基準信号源２１ｅと、基準信号の位相を制御してそれぞれＰＬＬ回路２１ｃ、２１ｄに供給する移相器２１ｆ、２１ｇとを有する。

【００３１】そして、二つのＰＬＬ回路２１ｃ、２１ｄによって設定される二つの第１局部発振器２１ａ、２１ｂの発振周波数は互いに同じ値なる。

【００３２】位相制御手段１９は二つの移相器２１ｆ、２１ｇの位相設定を直接行うが、これによって二つの第１混合器４、９に供給される第１局部発振信号の位相関係が決まる。従って、第１局部発振器２１ａ、２１ｂから各第１混合器４、９に供給される第１局部発振信号が間接的に位相設定される。さらには二つの第１混合器４、９から出力される第１中間周波信号同士の位相関係も決まる。そして図１の移相器１１ｂ、１１ｃの代わりに移相器２１ｆ、２１ｇが制御されるがその制御方法は図２で説明した内容と同じであるので説明を省略する。

【００３３】第２の実施形態における移相器２１ｆ、２ｇ１は単一周波数である基準信号の位相を変えるので広帯域の特性は必要なく、基準信号の周波数は第１局部発振信号の周波数よりも格段に低いので、移相器２１ｆ、２１ｇの挿入による第１局部発振信号の損失も無くなる。

【００３４】第２の実施形態においては局部発振手段２１に規準信号源２１ｅを設けて基準信号を発生し、移相器２１ｆ、２１ｇによって基準信号の位相を制御して各ＰＬＬ回路２１ｃ、２１ｄに供給したが、図4に示すように、デジタルシンセサイザによって基準信号を発生すると共にその位相を制御してＰＬＬ回路２１ｃ、２１ｄに供給してもよい。

【００３５】図4はデジタルシンセサイザを使用した場合の局部発振手段３１の構成を示しており、デジタルシンセサイザ３１ａ、３１ｂはそれぞれＲＯＭを有する。各ＲＯＭには１周期分の正弦波のデータが、振幅、位相ともに離散化されて格納されている。そして各デジタルシンセサイザ３１ａ、３１ｂにはクロックと周波数データとが共通に入力され、各ＲＯＭはクロックに同期して周波数が同じとなる正弦波のデータを発生する。

【００３６】また、各デジタルシンセサイザ３１ａ、３１ｂには個別に位相データが入力される。この位相データは位相制御手段１９から入力されるが、デジタル信号化されている。これによって正弦波のデータの位相が決められる。各ＲＯＭから出力された正弦波のデータはそれぞれD／Ａ変換器３１ｃ、３１ｄによってアナログ正弦波に変換される。このアナログ正弦波の信号が基準信号としてバンドパスパスフィルタ３１ｅ、３１ｆを介してそれぞれＰＬＬ回路２１ｃ、２１ｄに入力される。以上のようにデジタルシンセサイザを使用すると基準信号の周波数と位相とをデジタル的に設定できるので簡単である。

【００３７】

【発明の効果】以上説明したように、本発明では、互いに離間して配置された複数のアンテナで受信されたＯＦＤＭ変調信号をそれぞれ第１中間周波信号に周波数変換して合成し、合成後のＯＦＤＭ変調信号の電力が所定レベル以上となるための各第１混合器に供給される第１局部発振信号の位相設定を行う位相制御手段を備えたので、アナログ回路でダイバーシチ合成が出来る。従って、構成が簡単となる。

【００３８】また、局部発振手段は第１局部発振信号を発生する一つの第１局部発振器と、各第１混合器と第１局部発振器との間に介挿され、第１局部発振信号の位相を制御して各第１混合器に供給する複数の移相器とを有し、位相制御手段によって各移相器を制御して各第１混合器に供給される第１局部発振信号の位相設定をしたので、局部発振手段の構成も簡素化出来る。

【００３９】また、局部発振手段は各第１混合器にそれぞれ第１局部発振信号を供給する複数の第１局部発振器と、各第１局部発振器をそれぞれ制御する複数のＰＬＬ回路と、基準信号を発生する一つの基準信号源と、各ＰＬＬ回路と基準信号源との間に介挿され、基準信号の位相を制御して各ＰＬＬ回路に供給する複数の移相器とを有し、位相制御手段によって各移相器を制御して各第１混合器に供給される第１局部発振信号の位相設定をしたので、移相器は単一周波数である基準信号の位相を変えるので広帯域の特性は必要なく、また、基準信号の周波数は第１局部発振信号の周波数よりも格段に低いので、移相器の挿入による第１局部発振信号の損失も無くなる。

【００４０】また、局部発振手段は各第１局部発振器をそれぞれ制御する複数のＰＬＬ回路と、各ＰＬＬ回路に対応して設けられ、基準信号を発生すると共に基準信号の位相を制御して各ＰＬＬ回路に供給する複数のデジタルシンセサイザとを有し、移相制御手段によって各デジタルシンセを制御して各第１混合器に供給される第１局部発振信号の位相設定をしたので、デジタル的な位相設定が可能となる。

【００４１】また、加算器とＡ／Ｄ変換器との間には、合成された第１中間周波信号を第２中間周波信号に周波数変換するための第２混合器と第２混合器に第２局部発振信号を供給する第２局部発振器とを設けたので、第２混合器以降が一系統で構成されるのでダブルコンバージョン方式のＯＦＤＭ受信装置の構成が簡単となる。

【図面の簡単な説明】

【図１】本発明のＯＦＤＭ受信装置の第１の実施形態の構成を示す回路図である。

【図２】本発明のＯＦＤＭ受信装置の動作を説明するフローチャートである。

【図３】本発明のＯＦＤＭ受信装置の第２の実施形態の構成を示す回路図である。

【図４】本発明のＯＦＤＭ受信装置の第２の実施形態における局部発振手段の他の構成を示す回路図である。

【図５】従来のＯＦＤＭ受信装置の構成を示す回路図である。

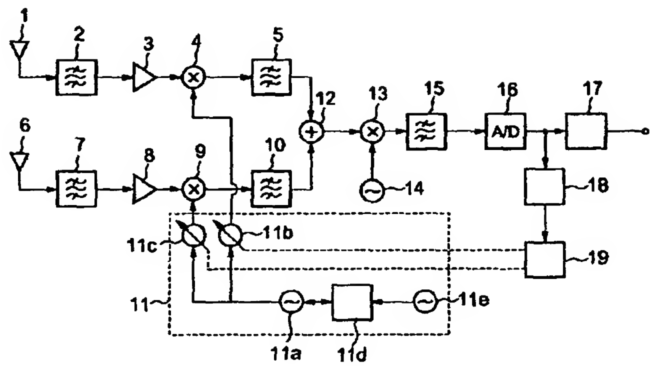
【図６】従来のＯＦＤＭ受信装置における相互相関検出手段の構成を示す回路図である。

【符号の説明】

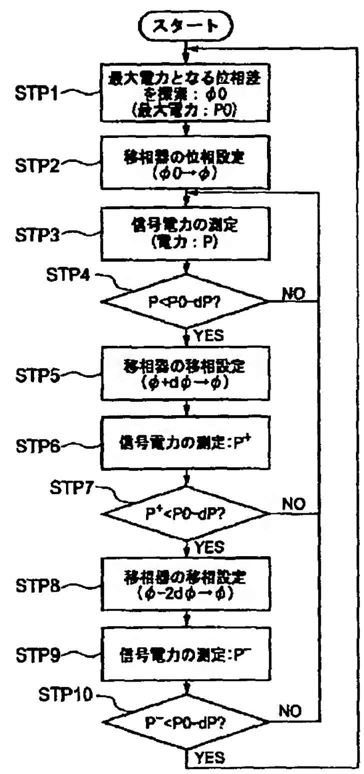
１、６　アンテナ
２、７　ＲＦバンドパスフィルタ
３、８　ローノイズアンプ
４、９　第１混合器
５、１０　第１ＩＦバンドパスフィルタ
１１　局部発振手段
１１ａ　第１局部発振器
１１ｂ、１１ｃ　移相器
１１ｄ　ＰＬＬ回路
１１ｅ　規準信号源

１２　加算器
１３　第２混合器
１４　第２局部発振器
１５　第２ＩＦバンドパスフィルタ
１６　Ａ／Ｄ変換器
１７　ＯＦＤＭ復調手段
１８　電力検出手段
１９　位相制御手段
２１　局部発振手段
２１ａ、２１ｂ　第１局部発振器
２１ｃ、２１ｄ　ＰＬＬ回路
２１ｅ　規準信号源
２１ｆ、２１ｇ　移相器
３１　局部発振手段
３１ａ、３１ｂ　デジタルシンセサイザ
３１ｃ、３１ｄ　Ｄ／Ａ変換器
３１ｅ、３１ｆ　バンドパスフィルタ

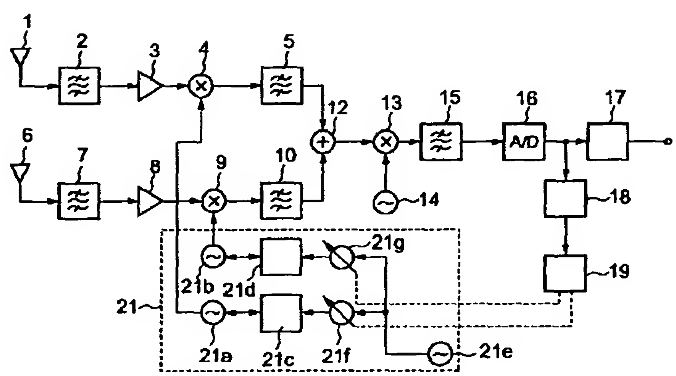
【図１】



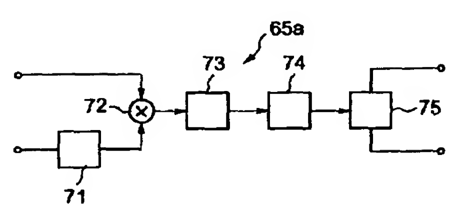
【図２】



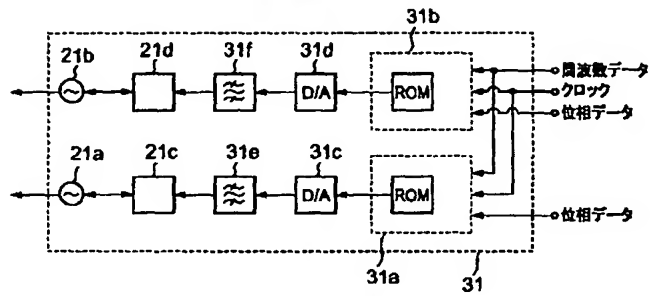
【図３】



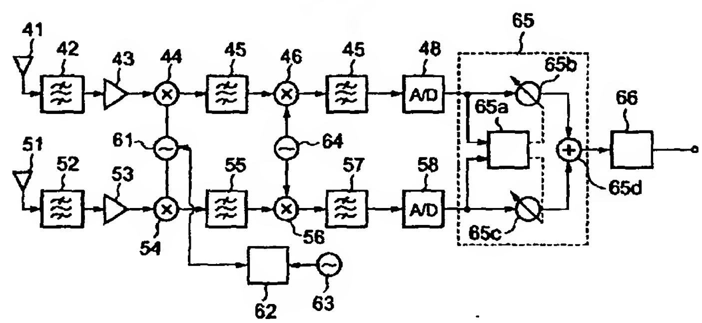
【図６】



【図４】


31b
21b
21d
31f
31d
D/A
ROM
周波数データ
クロック
位相データ
21a
21c
31e
31c
D/A
ROM
位相データ
31a
31

【図５】


65
41
42
43
44
45
46
45
48
A/D
65b
65a
66
61
64
51
52
53
55
57
58
A/D
65d
54
56
65c
62
63